Implementing JEDI into NASA GMAO's real time production suite

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Acknowledgement
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Introduction

- GMAO is developing a unified coupled data assimilation system, based on GEOS and JEDI, for weather analysis and prediction, reanalysis, composition forecasting, and S2S prediction.

- A significant challenge is the coordination of this development with other high-priority GEOS plans, including a major upgrade of the model physics and increased vertical resolution from L72 to L181.

- We're pursuing a phased approach to bringing JEDI into our core systems, starting with a soft transition away from GSI for the atmospheric system within the next year. This allows development to proceed in a timely manner while also allowing other important milestones to be met.

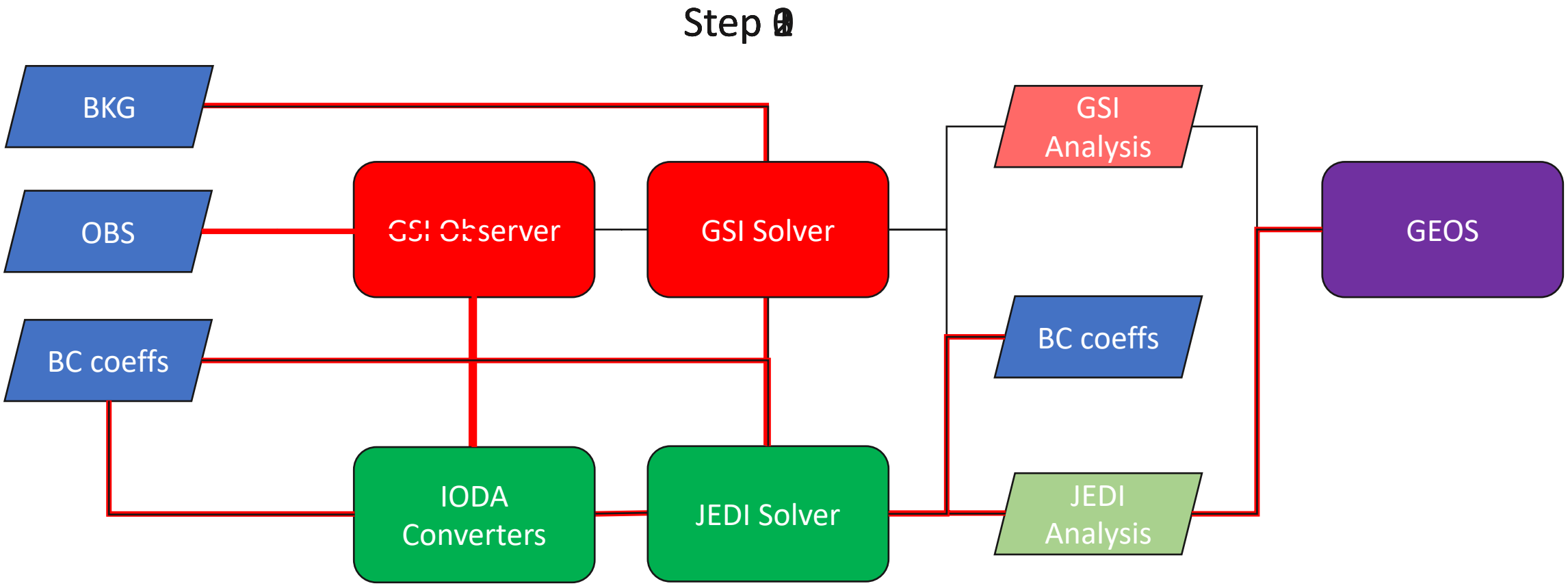
Transition of atmospheric DA from GSI to JEDI

Transition away from GSI will occur in a phased manner. Jedi will handle the central analysis but certain infrastructure, especially as it relates to observations, will be provided by GSI until that capability can be implemented in the JEDI framework.

	Step 0	Step 1	Step 2	Step 3	Step 4
Central analysis	GSI + JEDI (Passive)	JEDI	JEDI	JEDI	JEDI
Computing of bias correction coefficients	GSI	TBD	JEDI	JEDI	JEDI
Obs processing & thinning	GSI	GSI	GSI	JEDI	JEDI
Ensemble analysis	GSI	GSI	GSI	GSI	JEDI

Any time after step 1 we can implement model changes such as increasing the number of model levels.

Simplified Workflow



Towards atmospheric DA with JEDI

Even at step 1 there are several key capabilities needed in order to replicate the forecast skill seen with the existing system. At GMAO our focus is on developing the background error model and the observation operator configuration.

Background error model

- Built an ecbuild compliant repo (GSIbec) to house only the hybrid background error model code from GSI.
- Build SABER interfaces (blocks) for GSIbec to allow it to be called from any JEDI model interface.
- Implemented SABER block for interpolation from GSI lat/lon or Gaussian grids to generic model grids (and inverse).

Observation operator configuration

- Using GeoVaLs output from GSI we are aiming for as perfect as possible a match between GSI and UFO h(x).
- Building YAML files with all configuration options and filters.
- Adding new filters to UFO to match GSI capability.

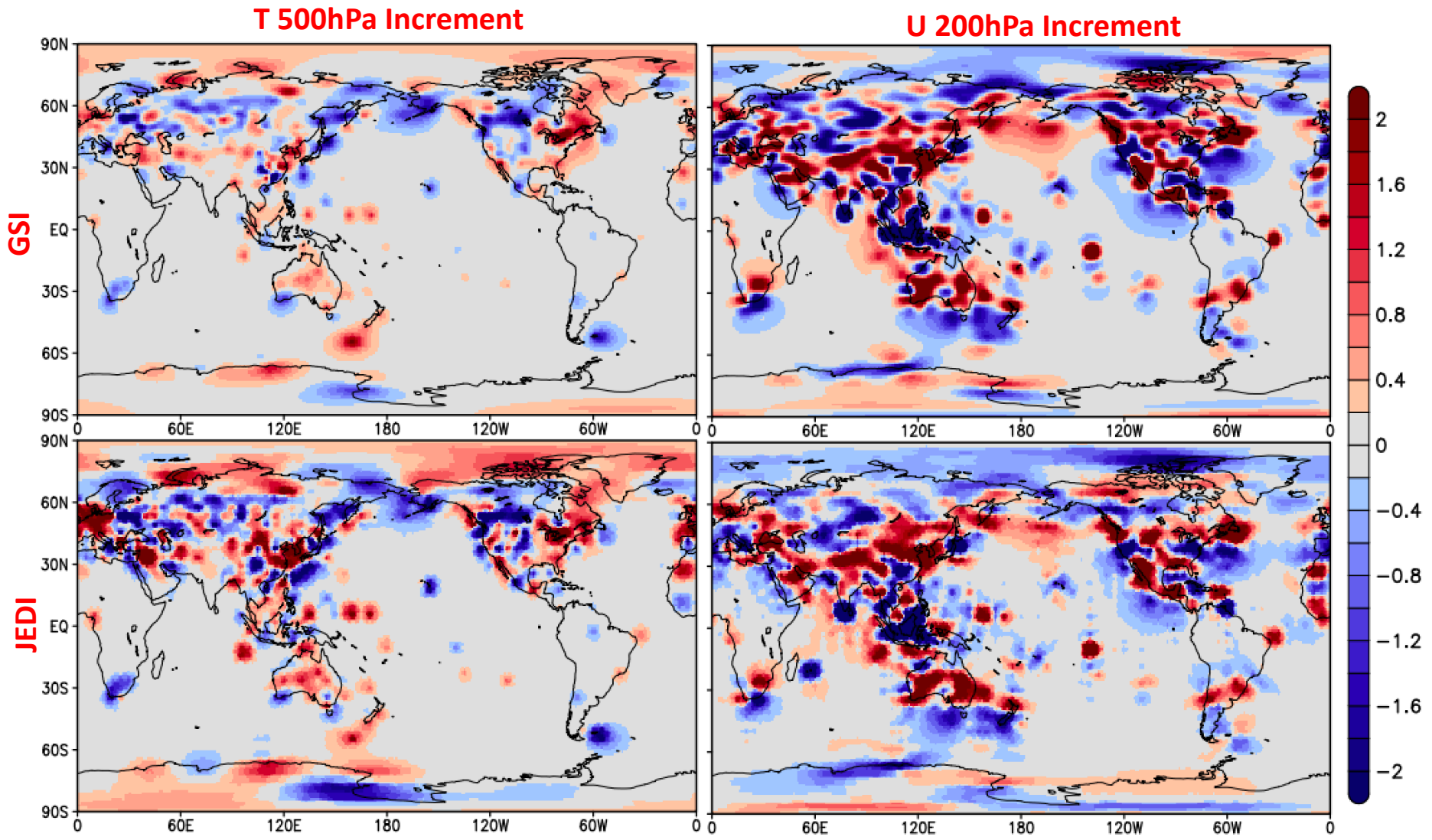
Background error model (See Ricardo Todling's poster)

System configuration:

- 3DVar
- No TLNMC
- Radiosondes
- 1 degree (C90)
- GSI QC Flags/Errors

To a good extent results are quite similar between the two analysis when the same observations are assimilated, and when the background error formulation is the same.

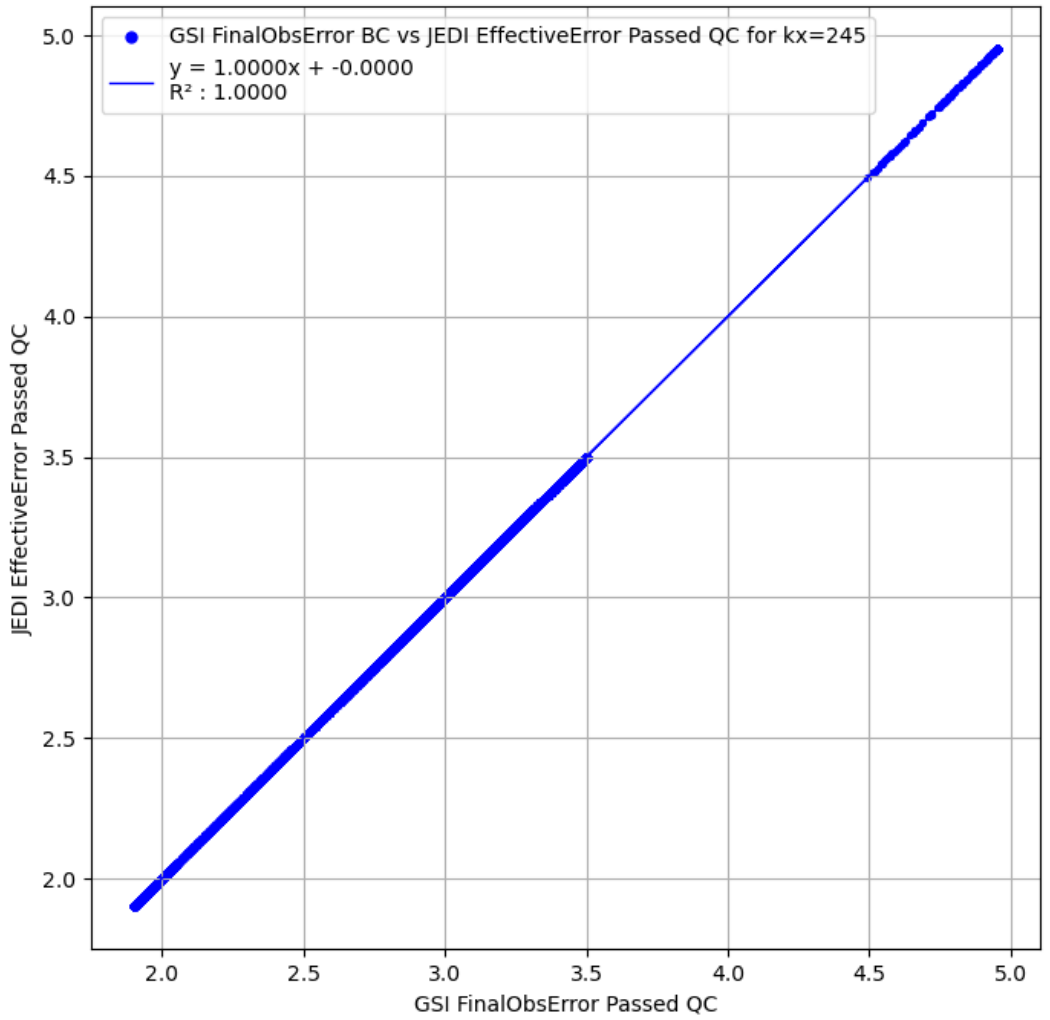
- q and tskin need attention.
- Working towards hybrid.



Observation operator configuration

OBS Type	Status
GMI	Done (matches GSI)
AMSR2	Done
MHS	Done
AMSU-A	Done
ATMS	Done
CrIS	Done
IASI	Done
AIRS	Done
AVHRR	Done
Ozone	Done
Conventional Winds	Sat winds, scat winds, sondes, aircraft
Conventional Temperature	Sondes, aircraft
Conventional Surface Pressure	Surface, Surface marine, sondes
Conventional Moisture	Sondes
GNSSRO	In progress

NESDIS GOES IR wind observations passing QC



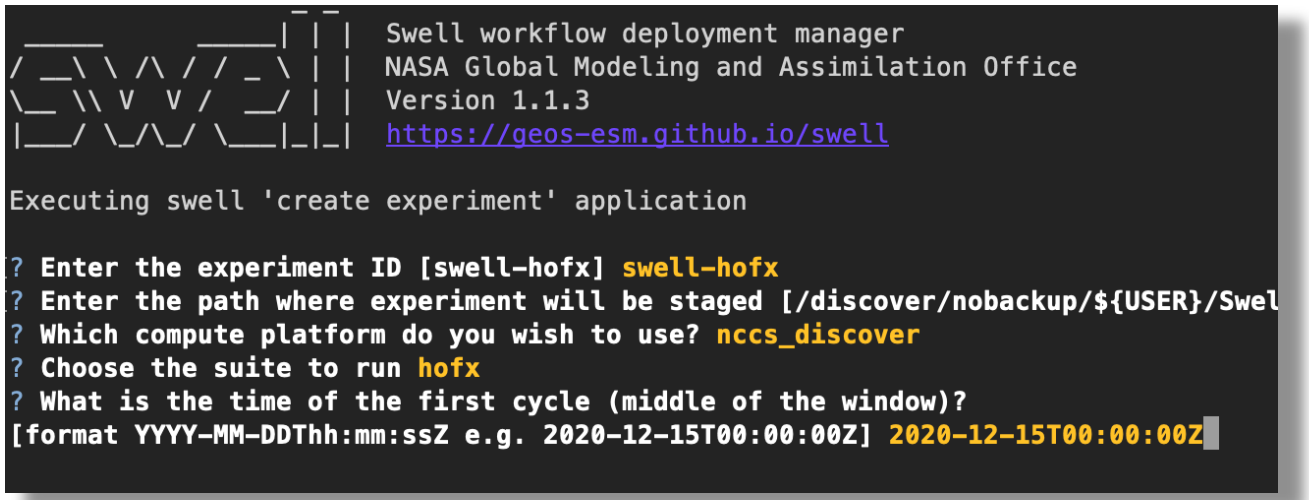
New filters and functions added to UFO

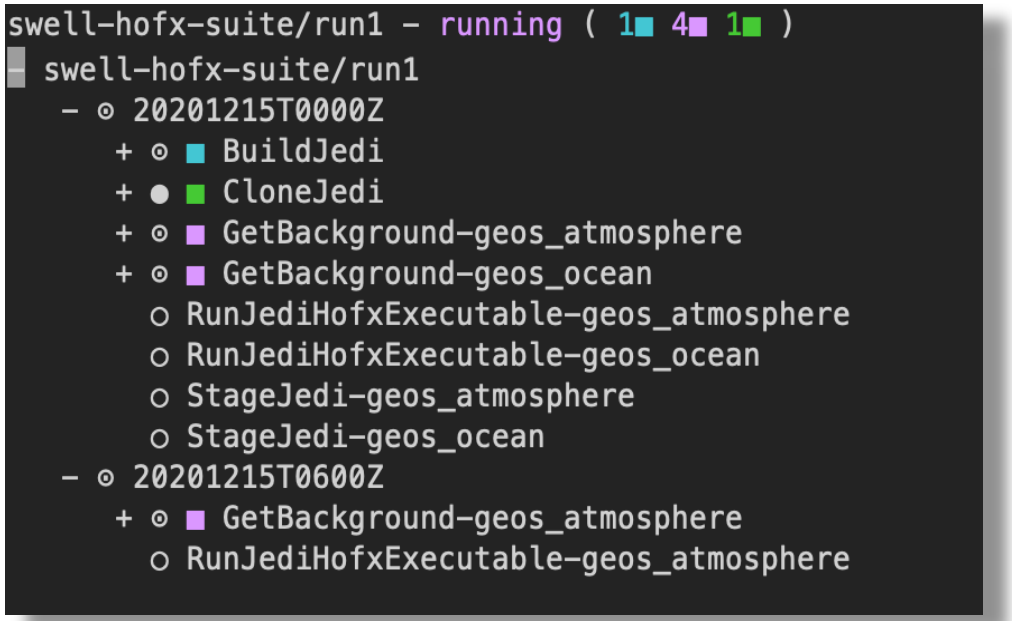
Platform	Code change	Status
Conventional	Duplicate observation error inflation (being parallelized)	In preparation
Conventional	Pressure/Geometric check (to be merged with duplicate check)	In preparation
Conventional	Surface pressure correction height variable option	PR awaiting approval
Conventional	Ambiguity check for scatterometer winds	In preparation
Infrared	Filter to reject IR observations over certain surface types	Merged
Infrared	Bug fixes in AVHRR cloud detection	Merged
Microwave	Added forward operator using GEOS hydrometeors for AMSR2 data.	Merged
Microwave	Updated bias correction configurations for AMSR2 and GMI.	Merged
Microwave	Updated cloud index calculation and its observational error inflation configuration for MHS.	Merged
Microwave	Added support for GPM GMI in UFO.	Merged
Microwave	Bias correction channel opt-out.	Merged
Microwave	AMSU-A, ATMS thick cloud quality control and cloudy bias correction. CRTM bugfix.	Merged

New workflow and ecosystem

Initial implementations of JEDI will utilize existing scripting. However, GMAO is developing a new workflow system called Swell (https://geos-esm.github.io/swell/) to handle running experiments with JEDI and GEOS.

- Uses CYLC 8 workflow manager with suite files generated using Jinja2 (all suites are coupled).
- Questionary for experiment setup and configuration generation.
- On-premises GitHub continuation integration to monitor compatibility between JEDI and Swell.
- Diagnostics using Eva-Swell integration (https://jcsda-internal.github.io/eva/). *See Kevin Dougherty's poster for Eva info*.
- Dynamic JEDI build system integrated into Swell (https://geos-esm.github.io/jedi_bundle/)



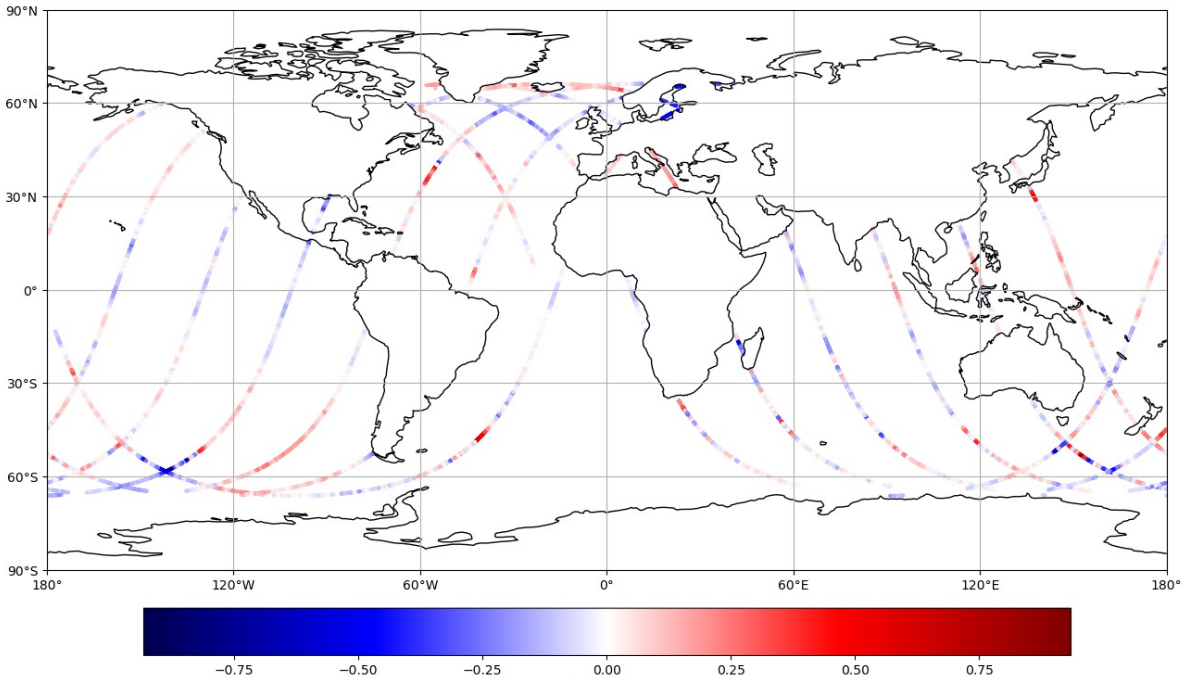


Ocean and Sea ice DA (work by Doruk Ardag)

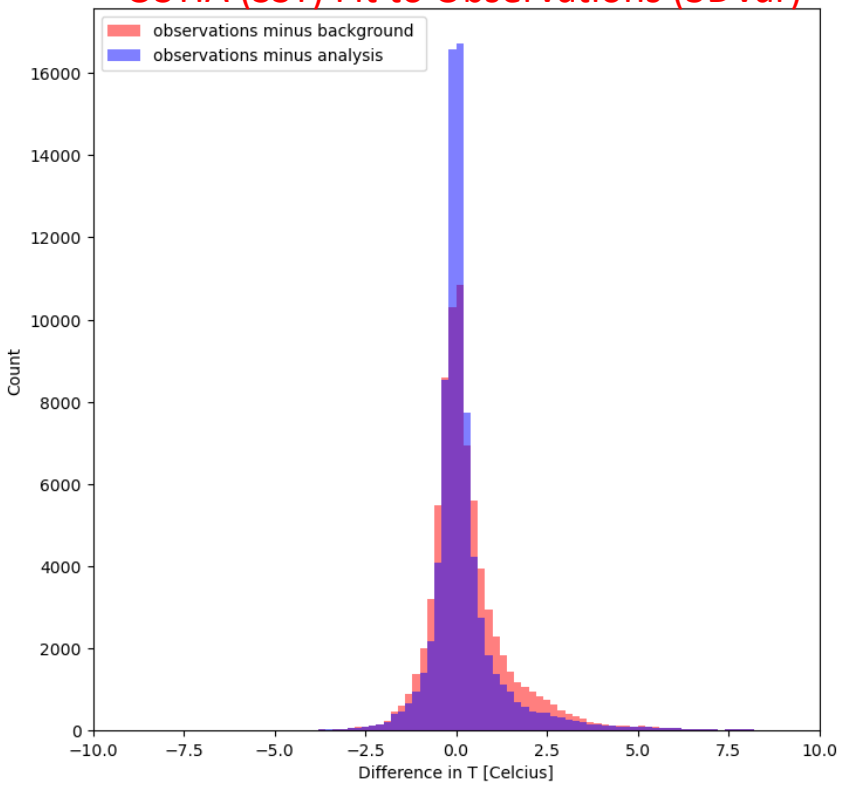
The MOM6 ocean model has been added to GEOS and we are in the process of transitioning from a MOM-5 with UMD LETKF system to a MOM6 with SOCA JEDI system.

Since there is no MOM6 baseline experiment, we are not pursuing the same systematic comparison as we are for the atmosphere. Instead, we are moving quickly to cycling the coupled model with atmospheric replay and evaluating the complete system. From there we will refine and iterate on the configuration.

ADT Observation minus Background (2020-12-15T00Z)



OSTIA (SST) Fit to Observations (3DVar)



Future plans

Near term goals

- Finish conventional observation operator configuration (~1 month).
- Complete GSIbec implementation in Saber for static B (~ 2 months).
- Implement hybrid B with TLNMC (~4-6 months).
- Complete transition of aerosol assimilation to JEDI (~3-6 months).
- Test and configure SOCA JEDI to run with MOM6 in GEOS.

Longer term goals

- Develop LETKF and EDA capability and compare their use for GEOS.
- Transition to Swell workflow system.
- Seek system improvements by utilizing range of SABER and UFO features.
- 4DVar. Two new hires to work on MOM6 adjoint and fast physics adjoint models starting soon.

We're hiring!

GMAO is hiring two new civil servants in data assimilation:

- ***Manage the reanalysis systems and delivery of MERRA3 (GS-14)***
- ***Oversee use of data from new missions, commercial acquisitions and other novel sources (GS-13)***